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ABSTRACT

This paper discusses the change process experienced by teachers participating in a study of a computer-based language arts instructional program for the early elementary grades--the Apple Learning Series: Early Language (ALS-EL). The study explored ways in which the teachers were implementing ALS-EL in their classrooms before attempting to determine whether the program was effective. Implementation 'quality' was measured by determining the extent to which teachers used a variety of ALS-EL software components, actively planned for curriculum integration, were familiar with all of the programs, made knowledgeable choices, and made appropriate use of hardware and peripherals including the sound synthesizer and printer. Results indicated that implementation quality varied widely across the six study sites, and that teachers' self-perceptions of their expertise with computers was highly correlated with their implementation quality. The roles of training, support, and leadership are discussed, as well as the ways in which a theoretical orientation to reading influences teachers' organization of instruction. It is argued that classroom design and management and, in particular, the teacher-learning relationship, are all factors that are affected by the teacher's prior experience and his or her general orientation to education. It is concluded that individual differences among teachers can make a substantial difference in the success or failure of implementing ALS-EL, and that time, resources, and support services are necessary for the successful implementation of innovative programs such as this. (24 references) (DB)

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IMPLEMENTING TECHNOLOGY IN THE CLASSROOM: Paths to Success and Failure

by

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IMPLEMENTING TECHNOLOGY IN THE CLASSROOM: PATHS TO SUCCESS AND FAILURE

Glen Harvey, Diane Kell, and Nancy Gadzuk Drexler*

> *The microcomputer is more than a new machine. As the most visible component in an array of microtechnologies, it is a symbol of the developing information society. As a tool with some "intelligence" and many connections, it and its users are forging new human-machine and machine-machine relationships. As a spawner of thousands of neologisms, it is affecting language and thinking within and across nations. As a novel cultural artifact, it and the large-scale microelectronic systems to which it is or can be linked are evoking novel dreams for human development and, at the same time, stirring deep fears about dehumanization (Culbertson & Cunningham, National Society for the Study of Education, 1986, p. ix).*

Such are the hopes and fears that computers engender as we move forward into a new era of technology. The nation's schools have not remained untouched by the recent rush to embrace the microcomputer. Between 1983 and 1985, the number of computers in U.S. schools quadrupled from approximately 250,000 to over one million. This number more than doubled again by 1989' to reach 2,355,000 computers. In 1985, 86 percent of the nation's schools had access to computers, with 24 percent having 15 or more computers. By 1989, the number of schools with computers had climbed to 96 percent; 57 percent of these schools had 15 or more computers (Center for Social Organization of Schools, 1986 and 1989 unpublished data).

But the real challenge is not simply to increase the numbers of computers in schools; rather, it is to show whether or not computers actually make a difference in the true process of schooling -- teaching and learning.

Unfortunately, in the opinion of LaFrenz and Friedman (1989),

> *there is little doubt that the vision of the computer's power to transform education has not been fulfilled. The hard fact is that the impact of the computer on the teaching and learning process has not yet been significant (p. 223).*

The Congressional Office of Technology Assessment (OTA) (1988) concurs:

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Schools have acquired computers rapidly . . . but most elements of the instructional process remain the same. This contrasts with other sectors of society, where technology changed the way business is transacted, medical problems are analyzed, and products are produced (p. iii).

According to Cohen (1987) and others (see, for example, Cuban, 1986), a review of the history of previous technical innovations in education reveals at least two distressing features: we have *"inflated hopes for their effects"* and few of these technical innovations *"were adopted, or widely used"* (Cohen, 1987, p. 154). Cuban (1986) warns:

the number of machines in schools grows, feeding researchers' appetites for statistics on number of machines per building. As with other innovations, however, such figures seldom bear a strong relationship to the frequency of teacher or student use (p. 77).

Continuing to add to the number of computers in schools is not enough. Without intelligent use, there will be no impact -- on students or teachers. Unfortunately, OTA reports that

despite the presence of computers in almost all American public schools, only half of the Nation's teachers report having ever used computers (p. 14).

Similarly, the ratio of students to computers equals approximately one computer per 30 children and, according to OTA:

not all students use computers, and it is estimated that those who do spend on average a little more than one hour per week on the computer, about 4 percent of their instructional time (p. 4).

Being "available" or "accessible" then, is a far cry from being successfully implemented and used effectively to positively affect students. What then, does it take to successfully implement a technical innovation in a typical classroom? Why are computers constantly in use in some classes and idle, collecting dust, in others? Why do some efforts to use technology in the classroom succeed while others fail? The purpose of this paper is to begin to answer these questions.

Background

During 1988-89, The Regional Laboratory for Educational Improvement of the Northeast and Islands conducted a study of a computer-based language arts instructional program for the early elementary grades -- the Apple Learning Series: Early Language (ALS-EL). Apple Computer, Inc., developed this program in 1987, with the intention of demonstrating the power and flexibility of the computer as a tool for language arts instruction inside the regular classroom, in the hands of the classroom teacher. In many respects, ALS-EL is less a program than it is a flexible tool for integrating computers and computer software into the language arts program at the primary (K-2) level.

The ALS-EL package includes: (a) a teacher's manual[2]; (b) a collection of ten widely respected software programs for early language development[3]; (c) peripheral devices

intended for use with the programs, such as a touchscreen, voice synthesizers, and a special children's keyboard; and (d) up to two days of training per school site. ALS-EL was intended for use with a suggested "ideal" configuration of hardware and peripherals for each classroom -- one Apple IIGS and two Apple IIe computers and an Imagewriter printer.

Over 1,000 students, 57 teachers, 62 classes, and 12 schools were involved in the Laboratory study during the 1988-89 school year. A total of 48 kindergartens, first and second grades, and special program classrooms all using ALS-EL were involved[4]; 14 kindergartens and first and second grades served as comparisons. The schools were geographically dispersed in the south western, midwestern, and southern parts of the United States.

The primary purpose of the study (known as the research on Computers and Literacy Development in Primary Classrooms Project) was to assess and portray the effectiveness of ALS-EL in typical early elementary grades. The project focused mainly on understanding:

- the process of implementing ALS-EL in a typical classroom;
- effects on teacher attitudes and behaviors, and on the classroom environment; and
- effects on student attitudes and behaviors[5].

Progress through the Change Process

One of the features of the study was that it placed emphasis on understanding how teachers were actually using ALS-EL in their classrooms before attempting to determine if the program made a difference in their practice or in student outcomes. Without an accurate picture of what has been implemented, it is impossible to understand the impact, if any, that occurs. Too often an innovation is denigrated and discarded as ineffective when, in fact, it has never been adequately implemented.

In order to assess and compare teachers' progress in implementing ALS-EL, a measure was needed that somehow captured differences in the degree to which teachers made use of ALS-EL in their classrooms. Yet, because the program was designed to be flexible and offered a wide range of possibilities, the measure needed to be similarly capable of accommodating the many different ways that ALS-EL might be effectively used.

We therefore constructed a measure of implementation "quality" based on our field researchers' perceptions of each teacher's use of the full variety of ALS-EL teaching resources. We asked field researchers to respond to 11 statements concerning each teacher's use of ALS-EL by assigning a value from 1 to 7, where 1 means the statement was "not at all true" and 7 means the statement was "very true" of the teacher. From those statements we chose 5 that our team of researchers felt were especially important to determining the quality of implementation. These included:

- uses a variety of ALS-EL software components;
- actively plans for curriculum integration;
- is familiar with all programs and makes knowledgeable choices;
- uses with all students, or varies use for good instructional reasons; and
- makes full or appropriate use of the hardware and peripherals, including sound synthesizer and printer.

By collapsing and averaging the ratings, we came up with an overall rating of the level of implementation quality for each teacher, divided into four categories -- high, medium-high, medium-low, and low.

Of our six sites, only one had all teachers achieving a "high" implementation rating as assessed by the above five listed statements. In the other five sites, there was substantial variation within site. In one site, teachers fell into each of our four implementation categories. In the four remaining sites, teachers fell within three of the four categories. Only in one site were there no high implementers. Overall, 37 percent of participating teachers were rated as high implementers, 23 percent -- medium-high, 23 percent -- medium-low, and 16 percent -- low.

These ratings are highly correlated with the teachers' self-perceptions of their levels of expertise. In a January teacher survey, we asked teachers to rate themselves as "novice," "intermediate," "advanced," or "expert" in six areas:

- general use of computers;
- general familiarity with the ALS-EL software;
- managing computer use (scheduling, grouping, etc.);
- selecting software for grade-level work, remediation, or enrichment;
- assigning activities within software to address specific objectives; and
- using teacher change options to customize software.

Individual teachers' self-perceptions of expertise were highly correlated with implementation quality in all but one of the six areas -- general use of computers. In addition, teachers in our highest implementing sites systematically rated their levels of expertise higher than did teachers in sites with a wider (and lower) range of implementation levels. These correlations give credibility to the reliability of our implementation rating, which is naturally vulnerable to systematic rater bias.

To further assess teachers' progress in adapting and implementing ALS-EL, the Stages of Concern Questionnaire from the Concerns-Based Adoption Model (CBAM)[8] was administered to teachers in both January and May. This questionnaire measured the concerns of teachers regarding ALS-EL at fixed periods of time. As the research predicts, teachers at higher levels of implementation had stronger "later stage" concerns

and less intense "early stage" concerns than did teachers still essentially struggling with issues of basic use.[7] Again, these findings support the reliability of our implementation rating, which can then be used in more targeted analyses of factors associated with successful -- or unsuccessful -- implementation efforts.

The Different Faces of the Apple Learning Series -- Early Language: Operational Variations

To identify the operational variations of ALS-EL in use[8], we developed an innovation component checklist, which our field researchers completed based on their interviews and observations. According to Loucks and Zacchei (1983), this dimension has particular relevance in assessments of educational computing:

> *Since the applications of microcomputers range from simple drills to programming to word processing, the innovation must be defined by its particular instructional application. A specific application that can be broken down into key components is much easier to describe, implement, and assess than an ambiguous, foggy spectra called "educational computing" (p. 27).*

The checklist we developed focused on student management procedures, the teacher's approach to integrating computers in instruction, variations in computer station design and location, and amount of computer use -- all of which were key categorical components of ALS-EL -- and included the following:

- Student Management Procedures. How do teachers control student access to the computers? Do teachers encourage students to work in pairs? How flexible are teachers in letting students choose computer activities to work on? How do teachers assign computer activities to their students? How often do teachers carry out whole-class or whole-group instructional activities? How aware are teachers of their students' work and progress on the computer?

- Approach to Integrating Computers in Instruction. Do teachers provide equal or differential access to computers and software? How selective are teachers in choosing software for their students to use? What kind of lesson planning and preparation do teachers engage in? How often do teachers or aides interact with students who are using the computers?

- Computer Station Design and Location. Do teachers maintain the configuration of peripherals and software for each of the three computer stations, as described in the ALS-EL manual? Do teachers encourage their students to interact while they are using the computers? Where do teachers set up the computers?

- Amount of Computer Use. In a typical week, how many days are computers used? In a typical week, how many hours are computers used? In a typical week, how many opportunities do students have to use computers? In a typical week, how many minutes do students use the computers?

We had originally anticipated that we would be able to identify a few definable configurations that might vary across or within sites, perhaps by level of implementation

quality and/or by (or within) site, or in relation to some other variable, such as approach to language arts instruction. However, the operational variations of ALS-EL proved to be sufficiently complex that major specifiable patterns were difficult to detect. While there were some macrolevel differences and similarities that could be identified and clustered, it appears that the variations in use are quite substantial with only one year of implementation. For example, in a school with only three ALS-EL classes, the following situations resulted from the introduction of the "computer center" to accommodate ALS-EL use. In one class, the computer center was the sole center and the teacher was frustrated that she lacked time to orient students individually, schedule ample use, and supervise students while at the computers. In another class, the teacher was not comfortable with computers and didn't begin using them until mid-year. She then set up self-sustaining high-ability/low-ability student pairs so that while students were at the computers, she could go on with her whole group activities uninterrupted. The third class had four or five well-established centers in the classroom already, and half of the class time was spent with small groups of students rotating between the different centers. The ALS-EL computer center fit easily into this established routine. A similar range of variations occurred across a host of other dimensions related to ALS-EL use as well.

Two of the four categories listed above -- "Student Management Procedures" and "Approaches to Integrating Computers in Instruction" -- appeared to be related to the teacher's level of implementation, and in many respects these relationships were somewhat predictable. Both these categories include at least some components that require a fairly sophisticated level of use of ALS-EL. CBAM would suggest that teachers who were still in the early stages of implementing a new program or practice would be far less prepared or likely to address issues of curriculum integration or other means of improving the program's outcomes for children, which is essentially what we found when comparing high and low implementers.

"Computer Station Design and Location," on the other hand, is much more likely to be a function of available space, personal management style, etc., and may be established relatively early on in the implementation process. In addition, teachers uniformly appear to have rejected one of the components -- distinctive configurations of peripherals and software for each computer, as described in the ALS-EL manual[9]. The vast majority of teachers apparently did not find the manual convincing on this matter and therefore used far more idiosyncratic station configurations to match the needs of their students and/or their personal instructional or management styles.

The final component category -- "Amount of Computer Use" -- is one about which we remain somewhat unclear. Ordinarily, we would have anticipated that the amount of computer use would have varied by level of implementation -- which it did with respect to the number of days per week that the computers were in use. Other related components (i.e., average number of hours per week, average number of sessions per child, average number of minutes per child) did not reflect differences by implementation level. Our major concern with respect to this is the validity of our measures of computer use. After analyzing teacher estimates of amount of computer use in relation to our research team's observations, we found it necessary to discount both sets of estimates as unreliable given substantial discrepancies. It was therefore impossible to determine with any validity the relation of amount of use to other factors.

It is clear, however, that if amount of use is considered a critical component, new methods other than self-reports are necessary to obtain reliable data.

Factors Contributing to Successful Implementation and Variations in Use

Why were some implementation efforts more successful than others after one year? Why did some teachers use ALS-EL more extensively and completely than others? Where should the energy go in implementation efforts when resources and time are limited? If the goal is to increase the effectiveness of ALS-EL, what factors warrant special attention?

One of the thrusts of the study was to gain greater understanding of some of the factors that could be hypothesized to account for variations in levels of implementation and types of use. As indicated above and elaborated upon later in this paper, we found substantial differences in the levels at which teachers implemented ALS-EL when described in even the most general manner -- not all of which can be accounted for by simple differences among sites. In all but one site, there were high implementers. And in all but two sites there were low implementers.

Similarly, not only did teachers reach substantially different levels of implementation quality, but the ways in which they used ALS-EL, particularly when we broke the program into its key components, varied considerably. In some respects, research would suggest that we would find such variations, given that this was the first year of implementing ALS-EL. Combined with the fact that the program is intentionally designed to be flexible and that teachers received very little training that might have resulted in more consistency in use, it is not altogether surprising that we identified such a wide range of differences.

Nevertheless, such differences in use are critical considerations when designing and planning an implementation effort as well as when conducting an evaluation of impact. It is difficult to achieve the desired outcomes or to create educational change if the program is not implemented fully or with a reasonable degree of fidelity to the original design. Similarly, it is impossible to consistently (and comparatively) assess the impact of something when it looks radically different across a range of classrooms, especially when major differences occur within as well as across sites.

Below, we examine possible explanations of these differences in levels of implementation quality and variations of use, all of which warrant further investigation before fully attributing them with any definitive causal effect. First, we explore the relationship of institutional, generally building-based factors that can impact implementation efforts, focusing on training, support, and leadership. Given that we not only found differences across sites but also within them, we then focus on individual teacher differences and the potential relationship of these factors to levels of implementation and configurations of use.

The Role of Training, Support, and Leadership

Training and Support. Research such as the Rand Change Agent Studies (Berman & McLaughlin, 1975; Berman & McLaughlin, 1978) made clear that adoption of an innovation is not equivalent to implementation and even further from impact at the classroom level. The Study of Dissemination Efforts Supporting School Improvement (DESSI) (Crandall & Associates, 1982) found that the "success" of new programs largely rests on the following factors:

- *The commitment of teachers, developed either through actual use of the new practice or before they began to use it*
- *Curricula or instructional practices that were carefully developed, well-defined, and determined to be effective*
- *Training by credible people . . . that included follow-up activities*
- *Assistance and support by an array of players, including other teachers, principals, district staff, and external trainers and linkers*
- *Attention to factors contributing to institutionalization (ensuring that the new practice remained)(Loucks, 1983).*

One of the most critical findings of the DESSI study for our project involves assistance. According to Crandall and Loucks (1983), *"new practices entailing a significant amount of change live or die by the amount of personal assistance they receive"* (p. 11). Resources -- human and other -- are critical. Unfortunately, Sheingold et al. (1987) found in their analysis of the retraining needs of teachers in urban schools for using computer technology that resources are severely limited, and there is a trend to deal with limitations through top-down, short-term teacher training and program implementations.

The Congressional Office of Technology Assessment (1988) found that four interrelated conditions concerning training and support are necessary if technology is to be used effectively by teachers, i.e.:

> *training in the skills needed to work with technology, education that provides vision and understanding of state-of-the-art developments and applications, support for experimentation and innovation, and -- perhaps most valuable of all -- time for learning and practice (p. 14).*

Many teachers in our study expressed the need for additional training and support beyond the one or two days provided with the ALS-EL package. Throughout the year, as teachers were struggling to begin using ALS-EL in their classrooms, administrators and teachers alike voiced a concern that more training was necessary in order to achieve the program's full potential. Bringing computers into the classroom is a major, complex innovation. The introduction of technology into a classroom actually includes two interdependent innovations: the technology -- the hardware -- and the program, which is itself often comprised of many components in addition to the computers. To implement such an innovation involves learning a new technology, gaining familiarity with

inconsistently documented software, troubleshooting problems with hardware and software, restructuring classroom management, integrating curriculum elements, and guiding and facilitating student use of the new medium for teaching and learning. Research suggests -- and our study confirms -- that training and support are essential ingredients in successfully accomplishing these tasks.

Overall, different teachers in the study voiced different types of training needs. Some required technical help with computers; some would have liked more in-depth training on the ALS-EL software; others expressed the need to learn more effective ways of integrating ALS-EL into the curriculum. Suggestions for further training included a six-week graduate-level course during the summer, five one-to-two day training sessions, bi-weekly on-site assistance, and a toll-free "hot line" to call in with problems. Suggestions for the content of training programs included basic computer applications and maintenance and more in-depth guidelines for integrating ALS-EL into the curriculum and using the computer as a diagnostic tool.

The need for additional training was a recurring theme and recommendation among study participants. Even in our highest implementing site, with its relatively high level of support and training, teachers felt they could have benefited from additional training. As one teacher explained, *"I feel I have a gold mine and I can't use it."*

According to one administrator:

> *I've thought about this a lot. I don't think the numbers of workshops or inservice are always adequate. We had [an ALS-EL trainer provided by Apple] come in one time. I really truly feel, and maybe this could have helped to turn it around, that [she] should have been in the building sometime, end of September, beginning of October, [and] spent a week here as a troubleshooter. "Now that you've had a chance to set up your computers, you've had two or three weeks, what kinds of problems are you having? How can I be of help to you? What do you see going on that needs change?" And then let [her] have an 800 number where once a week, from 3 to 5, where they [teachers] could call in with problems, not just problems with computers, but problems with kids who might not be motivated. . . . A few of them [teachers] talked about the fact that when the computers are on, all the kids, not just the ones on the computers, watched the computers rather than doing the lesson going on in the classroom, and how could the teachers -- maybe it's just a matter of moving the computers to another part of the room, or sort of talking to the kids, or having a class discussion. It also tells you that the kids are very interested in them if they're watching them instead of doing their other work. But I think there should have been someone, particularly the first year, who'd be there for them at the beginning, who'd come back a couple of times during the year. . . . There needs to be some system set up if these [computers] are going to be used appropriately.*

Another administrator concurred:

> *You can have the equipment, but if you do not provide the training, forget it. You're going to get very superficial use. . . . If you don't tie training into the program, it's a waste.*

Teachers agreed. The following comment alludes to attitudinal problems that might have been alleviated with more training or support:

> *I think outside training is helpful, but I don't think it should be rushed the way it was the first few sessions that we had. . . . Don't give me two days of training, and then throw me on computers. I'm sorry. I can see why the other teachers are upset about it. Now, I have a computer at home, and I like computers. But I don't think two days are enough, not when you're not familiar with computers, and you're afraid of them.*

Teachers at our highest implementing site received more training and support than teachers in other sites, largely through the initiative of school-based administrators; but even there teachers felt the need for more training. As one said:

> *My stance on that [need for training] hasn't changed. The way that I've adjusted to that [the lack of training] is that there are very limited things that I try to do with the computers. There is tons and tons more that I could be doing.*

Insufficient Time. Another concern among personnel at our sites was the need for additional resource time to integrate and implement the program effectively. As one administrator summarized it:

> *I think you need more time for teachers to be free of classroom responsibilities and for training. . . . There's not only the technology and the software, but you're dealing with the whole process of language learning, and it's a wonderful way to do it, but it just takes time.*

Many teachers felt that time limitations constrained them from implementing ALS-EL to the extent that they would have liked. Even according to teachers at our highest implementing site:

> *I use just so little of what's available or what the potential of it is simply because there's been so much to learn. So I've modified it by doing whatever is manageable. . .*

and

> *I have found that there really needs to be an adult at the computers because you are continuing, even with the Talking Text Writer, a lot of one-on-one conferencing. "What are you doing?" "Who are you writing about?" "What else could we do?" that kind of thing, that we need to spend time one-on-one doing. . . . I've resigned myself to the fact that I'm going to be here [at the computer center during center time]. This isn't an independent activity, as much as I would like it to be.*

Teachers expressed their concern regarding the lack of time in a variety of ways. Some felt that there was insufficient time to become familiar with the software. Others were concerned that they didn't have time to train students to use ALS-EL or to supervise their use of the computers. Still others worried about the time available for students to use the computers during the school day.

Leadership. Training and support are generally not enough to ensure successful implementation. The existence of strong, supportive leadership can have a powerful, positive impact on the implementation of an innovation. Where such leadership exists, the potential for success is enhanced and may influence individual teachers' attitudes.

Firestone (1989) identifies six leadership functions that are necessary for successful implementation:

- providing and selling a vision;
- obtaining resources (e.g., time, personnel, knowledge, materials, facilities);
- providing encouragement and recognition;
- adapting standard operating procedures;
- monitoring the reform effort; and
- handling disturbances.

These functions can be performed by a variety of individuals at various levels of the educational enterprise.

Unfortunately, the scope of our study did not allow an in-depth examination of individual leadership functions. However, we did find that administrators (building and/or district level) can have a key role to play in facilitating teachers' use of ALS-EL. They can facilitate teacher change in a variety of ways, e.g., arranging for resources and technical support, sensing teachers' concerns, following through to make sure that problems are quickly resourced, encouraging or guiding teachers in effective uses of the program. (Where there was not strong leadership, however, we did find individual teachers who still became effective, high implementers on an individual basis; these were teachers who were highly motivated to explore the use of computers in their classrooms and who felt comfortable experimenting with them on their own.)

Our highest implementing site provides an excellent example of the role strong, supportive leadership can play in an implementation effort. In this site, all teachers were integrating ALS-EL into their language arts program, and most were expanding their use of the computers not only in language arts but across the curriculum. ALS-EL was such an integral part of the language arts program that removing the computer stations would have radically changed the languages arts program, whereas in some of the low implementing classrooms, removing the computers might have had little or no effect on the program.

The on-site project leader[10] was the teachers' direct supervisor. She encouraged teachers to consider ALS-EL as a priority in their teaching responsibilities; provided for on-site modeling, support, and substantive direction; and cultivated a shared belief among teachers and administrators that their involvement in the project was a privilege rather than a burden. She also regularly visited classrooms and met with teachers in her school.

Teachers reported that she was *"very, very, encouraging"* and was *"the person who is most likely to pass new ideas along or make sure that we get what we need."* She, in turn, credited the teachers for their expertise and dedication. She said, *"When you are trying to get a program started, somebody has to take over."* She had confidence that teachers *"will turn out to be the resource [for each other], which is the way it should be, to have experts right on the staff."*

In many other sites, when teachers were questioned about who was in charge of ALS-EL and who they asked for help or support, teachers in a site would answer differently. Teachers found it a hard question to answer. There appeared to be no clear-cut leadership figure.

According to one study participant:

> *They [teachers] don't really know who to go to, and that's the problem. Some of them go to [school computer coordinator], or go to each other, or go to no one. Some of them don't do anything about it. Some of them will mention it to me in the hall. One or two of them have called the county computer person. That's a real problem because there's no designated person they feel they can go to, because they feel that if they come to me, that's fine, but I'm going to have to end up going to someone else anyway.*

The Role of Teacher Orientations, Perceptions, and Experience

While building-based factors such as training and support may contribute to different levels of implementation quality and types of use among sites, we also found considerable variation within sites, suggesting the influence of more individual factors[11]. While a great many factors can influence individual variations in use of an innovation, we were particularly concerned with the effects of teachers' theoretical orientations toward teaching and learning and their customary approaches to instruction and classroom management[12]. We paid attention to these issues, especially in our classroom observations, because we expected to find variations in the configurations of use associated with differences in teachers' beliefs and classroom practices. While ALS-EL has been promoted as a flexible tool that can be adapted to any language arts curriculum or method of instruction, we also thought we might find variations in levels of implementation quality associated with the differences in orientation and approach.

Individual adaptation of ALS-EL to suit the teacher's own needs and purposes was anticipated in the developers' conception of the ALS-EL program. We were told by some representatives of Apple Computer, Inc., that ALS-EL was deliberately designed to demonstrate the power and flexibility of the computer as a tool for language arts instruction inside the regular classroom. While some of the ALS-EL software components clearly represent a particular philosophy of early language instruction (e.g., the Sound Ideas software emphasizes phonics and word attack skills), teachers are expected to choose those programs and activities that best fit their own methods and curriculum.

<u>Theoretical Orientations to Reading</u>. Research has shown that teachers' theoretical orientations to reading have significant implications for the ways they perceive and

organize language development experiences for young children (DeFord, 1985). In addition, the findings from two projects at The NETWORK, Inc., extend this observation to the ways in which teachers use computers for language arts instruction. A major finding from these latter projects is that the teacher's overall philosophical approach to literacy instruction is one of the primary determinants of successful application of computers in implementing a writing process approach (Drexler, 1988).

Currently, there are sharp divisions among proponents of different approaches to language arts instruction in the primary grades. At one end of the continuum is the phonics approach, which emphasizes sound-letter correspondence and decoding skills in beginning reading and writing instruction. At the other end is a psycholinguistic or "whole language" perspective, which emphasizes making meaning with print, regardless of the age or experience of the potential reader or writer (see, for example, Goodman, 1986; Smith, 1983). In the middle of the continuum is a skills orientation, with an emphasis on word recognition. Especially near the edges of the middle range, teachers' approaches to reading instruction frequently mix practices characteristic of the phonics and skills approaches, or the skills and whole language approaches (DeFord, 1985). The instructional materials will differ in these approaches, as will the activities that students pursue during the instructional day.

In both October 1988 and May 1989 teachers were asked to complete the DeFord Theoretical Orientation to Reading Profile (TORP) in order to identify where they fall on this instructional continuum. Close to two-thirds of the teachers fell within the range describing a skills orientation and about three-tenths fell within the range describing a whole language orientation. Only three teachers, all from the same site, had scores indicating a phonics orientation. There was a clear clustering of teachers' scores within most sites, indicating remarkably cohesive views, which may have resulted from teacher selection (or self-selection), teacher development programs, or teacher influence upon other teachers in the same site.

Teachers' individual scores were quite stable from the beginning to the end of the year. The stability of the teachers' scores indicates that ALS-EL had relatively little impact on teachers' orientations to reading instruction, at least in this first full year of implementation. Inversely, however, teachers' orientations to reading did influence their preference for and use of different ALS-EL software components. Teachers were asked to rate the instructional value of each ALS-EL software component, overall at their grade level and for different subsets of students, i.e., high, average, and low achievers and limited English proficient students. There were strong relationships between teachers' theoretical orientations to reading and their ratings of the overall instructional value of four programs -- Muppets on Stage, Sound Ideas: Consonants, Sound Ideas: Vowels, and Sound Ideas: Word Attack. These are phonics and skills-based programs emphasizing letter-sound correspondence, decoding, and word attack skills. Their perceived instructional value was lower for teachers whose orientation was more towards whole language -- and higher for teachers emphasizing the phonics approach.

Regardless of orientation, most teachers rated Talking Text Writer (a word processing program and voice synthesizer specially designed for children) relatively high in instructional value. In discussing its use, however, some differences emerged that reflected orientations to language arts instruction. For example, one teacher with a

negative view of the Muppet and Sound Ideas software liked the fact that both ColorMe and the Talking Text Writer encouraged creative flexibility: *"I use the ones that I consider to be open-ended and [that] allow the children to write within context."* A teacher with positive feelings toward Sound Ideas emphasized Talking Text Writer's ability to reinforce phonics skills:

> *[I use the Talking Text Writer] to develop primarily the children's writing and thinking and creative skills. Also to reinforce their phonics skills. I find a lot of them are using their phonics to sound out words, much better than they were at the beginning. So it has helped some of them develop and use the skills.*

Further direct observation would enable us to determine if, in fact, there were consistent differences in the way Talking Text Writer was used, relative to teachers' orientations to reading and language arts. Since Talking Text Writer was judged by teachers to require more ongoing teacher supervision than other software, it might be that at this point in implementation, the major differences were in amount of time teachers were willing or able to devote to Talking Text Writer. However, as their comfort with ALS-EL increases, they might demonstrate increasingly different kinds of use, reflecting more their orientations to language arts instruction.

We found that teachers' theoretical orientations to reading were not related to the level of implementation quality they reached during the year. There are representatives of all orientations to reading among low implementers, and both skills and whole language teachers among high implementers. While no phonics teachers in our sample were high implementers at the end of the first year of implementation, only three teachers in the study held a phonics orientation, perhaps reflecting current popularity of a more whole language approach among the profession. It seems it might indeed be possible to adapt ALS-EL to any language arts curriculum, as long as other factors influencing success are favorable.

Classroom Design and Classroom Management. Except where computers are already in the classroom, ALS-EL involves the creation of a distinctly new learning "center." How the teacher uses this center and how easily he or she manages children's use of the center are greatly affected by the teacher's prior experience with the centers-based approach as well as his or her general orientation toward the teaching and learning process (e.g., whether he or she expects to be in direct charge of all learning activities in the classroom).

The addition of a new thematic center -- the computer center -- may affect the classroom in a variety of ways. About half the classrooms in the study, other than Chapter 1 pullout classrooms, already operated with a centers-based design. Adding a computer center was consistent with the teachers' overall classroom organization and management approach. Some teachers who were low implementers for other reasons nevertheless thought it should be easy to fit computers into their routine classroom practices. One of these teachers, a low implementer, said the computers were *"just another center, like clay"* -- which to her meant she would not have to give it much of her attention. Some teachers felt they needed to supervise the computer center more than some other centers, especially at the beginning of the year; but toward the end of the year they were more relaxed. According to a medium-high implementer, *"At the*

beginning, the impact was on mechanics and on fitting programs in with the least disruption. Now there's not much impact [on classroom management] because it just fits in with what I'm doing."

Most teachers concurred that the computers provided *"a very valuable station."* There were, however, some exceptions to positive acceptance of computers in the classroom. One relates to inflexible use of awkwardly constructed physical space; another relates to classroom management practices. In both situations, the addition of the computer center caused a major change, one that was generally not successfully managed in the first year of implementation.

In one site, the participating classrooms had two distinctly different configurations. Some of the classrooms were large, self-contained classrooms with plenty of storage and desk space, bathrooms, sinks, closets, and doors that shut. Other classrooms, on the other hand, had been built during the "open classroom" era and were small, hexagonally shaped "pods" opening into a large open space. It was impossible to separate the classrooms from the open space, either visually or acoustically. These teachers had to contend with substantial, ongoing commotion from the open space. In addition, the classrooms themselves were very small, oddly shaped, and lacked storage space.

The addition of the ALS-EL stations into these "open" classrooms made a profound change in the instructional environment. Crowded classrooms suddenly became extremely crowded classrooms. Even if and when teachers liked peer tutoring and cooperative learning activities from a pedagogical perspective, they found the activities were next to impossible from a pragmatic perspective. According to one teacher, *"The best location [for the computers] is outside the classroom. Kids don't learn if they're being quiet, and computers make noise."* Another concurred: *"The class is much noisier when the kids are using [the computers]. Kids talk which I think is great, but because the class is so small it's disruptive."* By May, this teacher believed, *"All the computers should be in one area, outside the classroom."* These teachers were rated as the lowest implementers at the site. All the teachers in the open pod classrooms were rated as low or medium-low implementers. The teachers with larger, quieter classrooms at this site were implementing ALS-EL at medium-high levels.

The classrooms in another site did not present the same physical limitations as those described above. Nevertheless, at least three teachers in this school believed the computers would be better placed out of the classroom as well. In these classes, computers were the only center-based activity. Even in a class that had some "play" centers, children spent most of their time at their desks; the "play" centers were used just 30 minutes each week. According to this classroom's teacher, *"Basically, the computers need to be in a computer room, like upstairs, and have one teacher who is doing the computers, as far as I'm concerned."* This attitude coincided with the attitudes of the majority of the teachers at the above-cited site with limited physical space. Integration and incorporation of the centers into these classrooms was relatively unsuccessful during this first year of the implementation.

Teaching-Learning Transactions. There is research that suggests that the type of learning and intelligence theory and teaching approach, such as authoritarian, may influence how teachers use computers and thus not only the amount of computer activity

in the classroom but also the children's exposure to different kinds of computer activities (Ginsberg and Selman, 1988). We found that implementation levels and configurations of ALS-EL use may be influenced by the nature and variety of teaching-learning transactions customarily allowed in the classroom. It appears that there are patterns of relationship between some kinds of existing or ongoing teaching-learning situations and different levels or configurations of use.

At one extreme was the situation in which the sole locus of instructional control was the teacher, instructing the class as a total group. Instruction went from the teacher to the group of students, with no opportunities for the students to communicate back to the teacher (other than to answer direct teacher questions) or to each other. Instruction was static and uni-directional. In classrooms with limited kinds of teaching-learning transactions, in which most instruction was teacher-directed and aimed at the whole class or at large sub-groups, the amount of activity, movement, conversation, and play seen was also very limited. Instruction was prescribed by the teacher and relatively standard: students were directed to learn the same things in the same way, although they were expected to learn them independently rather than cooperatively. The physical components of a classroom with limited transactions would typically include a teacher's desk, student desks in varied configurations, and a small table and chairs for reading groups. The ALS-EL station, when added, created a new kind of classroom structure. In at least one situation, the computers were not added to the classroom at all, but to a cloakroom between two project classrooms.

At the other extreme was the classroom situation with several interacting loci of control: the teacher, the individual student(s), and a group or groups of students (whole class or small group). Within this situation, the teacher, individual students, and/or a group of students interacted with each other frequently. Instruction and communication were fluid. Each locus engaged in frequent self-checking, i.e.: we observed groups involved in peer tutoring, individual students revising works-in-progress, and heard teachers report on their own "progress checking." In classrooms in which the loci of instructional control might lie at any given time with the teacher, individual students, and/or groups of students, the amount of activity, movement, conversation, and play seen was high, relative to the classrooms described above. In these more active classes, there was flexibility in learning style, rate, and content. There was often a variety of learning centers set up in the classroom to accommodate these simultaneous teaching-learning interactions. The ALS-EL station, when added, became an additional center, rather than a unique entity in the classroom structure.

Most of the classrooms we observed allowed at least moderate levels of multi-directional teaching-learning interactions; the differences were not so much whether these interactions occurred, but the extent to which they dominated the instructional day. In some classes, for example, some of the school day might be teacher-directed, with limited "choice" times in which multiple teaching-learning interactions occurred. In other classes, multiple teaching-learning interactions might be the standard mode of instruction throughout the day.

Less than a quarter of the classrooms in our study (not counting the Chapter 1 pullout classes) fit the first extreme, with the teacher as the sole locus of instructional control, primarily directing the class as a whole. Each of these classrooms was also a medium-

low or low implementing classroom. The ways in which these teachers implemented ALS-EL was through replicating their classroom teaching-learning model as much as possible: teachers primarily used the more closed-ended software packages with clearly "right" and "wrong" responses to a computer stimulus. The locus of instructional control went directly from the teacher to the computer. The scheduling and computer configurations in these situations also mimicked the classroom environment as much as possible. In one case, the computers were clustered together in a cloakroom between two ALS-EL classrooms. One of the teachers using this computer set-up allowed her students to select computers as an activity during the daily "play" time, as well as assigning individual students to work with an aide during the language arts block. However, the other teacher managed to incorporate the computers into her program only by setting aside 90 minutes each week for children to rotate through the computer stations in groups of 12, each group spending one-half hour on the computers, ten minutes per station. Even so, she saw the computers as a profound disruption of her classroom routine:

> *Basically, all I see is a bunch of disturbance! I see the kids more talkative. I see that I have to constantly discipline them more. . . . Whenever you give these kids too much free time -- free time to explore and to do things, and they're not in a structured, learning-type thing -- they're unsupervised; they learn habits that come back into the classroom.*

When the researcher asked whether she felt she had seen only negative outcomes so far, she replied:

> *Well, I wouldn't say it was negative. I would say it was <u>different</u>, because what I perceive as negative might be positive as far as other people are concerned. Some educators want children to be able to troubleshoot and to explore and "be creative" and [to these educators] noise is perfectly acceptable.*

Here, there was no student collaboration, and students responded individually to the same instruction from the teacher, in this case the computer. The student-computer ratio necessitated some physical shifting of students, but that appeared to be the only concession to the innovation in this classroom.

On the other hand, all but one of our high implementing classrooms were ones in which multiple kinds of teaching-learning interactions were common. Perhaps this is the type of classroom in which ALS-EL as currently configured can be implemented most easily, because it fits in readily and requires relatively less change in classroom management on the part of the teacher. When different kinds of learning activities are already occurring simultaneously in the classroom, there may be an easier carry-over to accepting and planning for different computer-based activities, even though this requires significant teacher involvement. According to one high implementing teacher:

> *I think the reason that they [the children] are so free with this [using the computers] is that I have a very open classroom. I do have a program of studies -- in other words, mandates, I mean -- but it's absolutely very open. It's fantastic -- a literature-based, integrated, whole-language approach. And I have found that we're doing much more talking than we used to, just as a group, with each other. I mean,*

there's just not a really quiet time. . . . They write in their journals and they read -- just come to the book boxes and take something, and they can read by themselves. Usually, after maybe 20 minutes, I'll notice that they'll be pairing up and reading, and sometimes a little group will get together. . . .

Conclusions

The Computers and Literacy Development in Primary Classrooms Project confirmed much of what the research on educational change and improvement would predict. The project served as a reminder of the difficulty of implementing an educational innovation, particularly a technological one as complex as ALS-EL, which includes hardware, software, peripherals, and training. The statements that *"change is a process"* and *"change takes time,"* while perhaps commonplace, were constantly reinforced as critical considerations.

The project's findings also reinforce the view that it is unreasonable to expect that ALS-EL -- or any major innovation -- would have an enormous positive impact after only one year. In many respects, if ALS-EL were to be fully implemented by the end of one year, that in itself should be considered more than ample first year success under a realistic appraisal of what such an implementation effort requires.

Levels of implementation quality varied considerably across and within sites. Similarly, a wide range of types of ALS-EL use were evident. In fact, even though we were aware of the great "flexibility" of ALS-EL to adapt to different teaching and management approaches, we were surprised at the considerable variation in types of use.

That there were considerable differences, however, can be judged a strength of ALS-EL, given Apple Computer, Inc.'s, intention to develop a program that is adaptable to a variety of teaching and learning styles. Teachers were able to "fit" ALS-EL use into a broad range of instructional and management styles.

On the negative side, however, some aspects of ALS-EL did not appear to be fully utilized because of the "flexibility" of the program. For example, although it appears that the developers had in mind the use and usefulness of an assortment of software components, many teachers did not find it necessary to provide opportunities for students to use all these components. Ultimately, it is possible that the impact of ALS-EL will be limited in some respects as a consequence of this type of flexibility.

Nevertheless, providing a tool that empowers teachers to use their judgment about what appropriately reinforces and supports their individual instructional program must, on balance, be considered a major strength of the program.

A broad array of factors can be associated with the variations in types of use and levels of implementation quality. Some factors are organizational in nature, including the need for:

- training that goes well beyond one-shot sessions by being comprehensive, extending over time, and including follow-up activities;

- ongoing (probably building-based) support both with respect to hardware and software "problems" as well as a range of issues related to teaching and instructional integration; and

- strong leadership in support of the implementation effort.

Others factors are more personal in nature, reflecting individual differences among teachers, including teacher attitudes, perceptions, beliefs, prior experience, behaviors, etc. Certain of these factors can make a substantial difference in the success or failure of implementing ALS-EL, for example:

- the orientation of a teacher toward reading (i.e., phonics, skills, or whole language) strongly influences the ways in which ALS-EL was used; the priority given to using (or not using) different software components showed a substantial relationship to teacher orientation, for example; levels of implementation quality are not related to teacher orientation (although this is likely because we intentionally designed a measure of implementation that did not favor or reflect any particular orientation);

- the teacher's prior experience with a centers-based approach affects how she/he manages children's use of the center as well as how she/he actually uses the center, given that ALS-EL involves the creation of a distinctly new learning center within the classroom; and

- the teaching-learning transactions related to the teacher's orientation toward teaching and learning (e.g., beliefs about appropriate locus of control, the amount of allowable noise) influence both the level of implementation quality and the type of ALS-EL use.

The implications of our study for successful implementation of ALS-EL, or any other major innovation, support the findings of the DESSI study cited earlier. If we hope to integrate computer use into the classroom, extensive training and ongoing support during the implementation process need to be provided in terms of technical assistance, release time, curriculum modeling and suggestions for effective integration within the content areas, and clear goals within the educational system that the innovation addresses. The innovation cannot be viewed by those expected to implement it as something separate and extra, but as something that works to enhance, rather than compete with, the existing curriculum and educational goals. Any major implementation effort should provide adequate training, ongoing support, strong leadership, and a sustained effort if the odds of success are to be substantially increased. Strong leadership appears to be an important element for widespread implementation, once some initial training is in place. This leader (or leaders) can then assure that ongoing support is both available and relevant.

ALS-EL is intentionally designed not to follow in the path of many "teacher proof" programs of the past. Instead, it reinforces the recent shift to teacher decision making and therefore is designed to serve as a tool to be used in the classroom to assist teachers regardless of their instructional approach. As a result, in many respects it is only as effective as the teacher using it. Clearly, with such a program, the teacher is the critical element in its success, and as such, must be assisted throughout the

implementation process in order to increase the possibility of successful, effective use.

What then does this say to educators and policy makers considering implementing a technical innovation?

- Value the implementation process and understand that change takes time, energy, resources, skills, and commitment. Don't assume that the introduction of a new program can be accomplished overnight or without a hard struggle. Devote the necessary time and resources to adequately plan for and carry out the implementation effort -- and provide teachers with the time they need to learn, feel comfortable with, and incorporate a new program into their classrooms. Researchers and evaluators can contribute to this orientation by becoming more aware of and responsive to implementation issues and questions implicit to their work. Technology-focused researchers and evaluators should incorporate this body of knowledge into their repertoire and begin to contribute more to our understanding of how technology can be used effectively under a wider range of conditions.

- Provide adequate comprehensive training and ongoing support. Teachers cannot incorporate something new into their classroom through sheer commitment alone. New skills and knowledge will be needed and teachers cannot be expected to gain these on their own. District and/or building personnel can arrange for inservice programs that provide necessary training. In addition, an on-site support person should be designated -- and given adequate time and resources to carry out this role. Developers and/or marketers of software (and hardware) can facilitate training in a number of ways: (a) a training-of-trainers program could be sponsored so as to develop the necessary cadre of trainers, who could provide services on a fee-for-service basis to schools needing such trainers, thereby increasing the number of qualified trainers and improving the quality of training teachers receive; teachers currently using the program (in this case ALS-EL) could become certified trainers through this program; (b) high quality long-term training could be made more accessible; (c) an 800 number could be provided for teachers to call who were experiencing technical problems; knowing that there is a ready technical expert at the other end of the line could eliminate a number of problems and nagging concerns.

- Know the orientations, approaches, styles, and experience base of teachers before embarking on an implementation effort. When there are incongruities and/or areas of possible conflict (with the new program or practice), make expectations clear, plan to provide additional training and support, and allow the necessary time for changes in attitudes and behavior to occur.

- Ensure that the implementation effort has the support of appropriate building and/or district personnel. While this need not be the principal, for example, key actors and influentials need to be supportive of the effort and this support needs to be evident on a continuous, visible basis. Leadership to see the effort through the hard times and to maintain a level of commitment and interest is critical.

- Negotiate with key influentials about the ways in which success will be judged prior to the onset of the implementation effort. Improvement seldom occurs

rapidly. Schools that experience constant pressure from their boards to produce quantifiable increases in student achievement at the end of one year of implementation are bound to experience undue stress to perform, and probably to compromise the integrity of the program. Researchers and evaluators can assist in this process by developing more appropriate measures and methods to assess the short- and long-term impact of innovative programs such as ALS-EL and by demonstrating alternative avenues for defining and determining "success" and "effectiveness."

As innovative programs and practices embrace the leadership role of teachers, the pressure to support teachers in assuming their new roles and responsibilities will increase. Regardless of the technical innovation, as in the case of ALS-EL, student impact is likely to be contingent on teacher ability and effectiveness. It is therefore critical to recognize teachers as the key to success -- or failure -- and to provide what is necessary to ensure that they succeed.

~ NOTES ~

1. Schools that have only students below grade 4 are not included in the 1989 data.

2. The teacher's manual describes the different software programs; provides a scope and sequence chart that matches the software to typical K-2 language arts objectives; suggests ways of introducing children to computers; and describes sample lesson plans that incorporate a variety of computer and other learning activities.

3. The software assembled for ALS-EL represents some of the best software available from commercial publishers of software for young children. (For an independent rating of early childhood software, see Buckleitner, 1989). They were packaged together with the intent of giving teachers resources to use in creating an integrated, multifaceted language learning experience for children in their classrooms. The software includes:

- Muppets on Stage, Muppetville, and Muppet Word Book (from Sunburst Communications, Inc.);
- Touch 'N Write (also from Sunburst) [Note that teachers in one site asked for and received Sunburst's Tiger's Tales];
- Sound Ideas: Consonants, Sound Ideas: Vowels, and Sound Ideas: Word Attack (from Houghton Mifflin);
- Talking Text Writer (Scholastic Software, Inc.);
- ColorMe (Mindscape, Inc.); and
- Explore A Story: Where Did My Toothbrush Go? (D.C. Heath).

These software components represent quite different approaches to early language development, ranging from several phonics and skills practice programs (the Muppets and Sound Ideas) and a handwriting program (Touch 'N Write) to a word processing program specially designed for children (Talking Text Writer) and two programs that allow children to produce and/or modify both pictures and text (ColorMe and Where Did My Toothbrush Go?). Taken together, these programs are methods for attending to the varying learning styles and needs of young children and the varying skills involved in early language development.

4. Each school using ALS-EL included a different array of classrooms. Altogether, the 48 classes included 18 kindergartens, 20 first grades, and 10 "other" classes. These "other" classes included 1 early childhood program, 1 bilingual and 1 ESL second grade, and 7 second through fifth grade Chapter 1 pullout programs. The kindergartens included 14 "regular" classes, 1 bilingual and 1 ESL class, 1 Chapter 1 pullout class, and 1 Chapter 1 all-day class. The first grades included 16 "regular" classes, 2 bilingual classes, 1 Chapter 1 pullout class, and 1 HILT (High Intensive Language Training) class.

5. Particular emphasis was placed on examining classes that included students often considered to be at risk of failing school.

6. We made extensive use of CBAM concepts in our research, especially as they have been adapted in prior work by The Regional Laboratory and its sister organization, The NETWORK, Inc. (see, for example, Loucks-Horsley & Hergert, 1985; Harvey & Crandall, 1988; and Harvey, Loucks-Horsley, Cox, & Crandall, 1984). Most importantly, we attempted to assess the several dimensions of the change process as there are experienced by individual teachers (i.e., Stages of Concern, Levels of Use, and Innovation Configurations) with varying degrees of fidelity to the CBAM diagnostic approach. The Stages of Concern (SoC) dimension addresses *"how teachers or others perceive an innovation and how they feel about it"* (Hall & Hord, 1987, p. 13). CBAM predicts that individuals involved in a change effort, such as the integration of ALS-EL into the classroom, will progress through seven recognizable stages of concern: awareness, informational, personal, management, consequence, collaboration, and refocusing. The second dimension, Levels of Use (LoU), was much harder to apply in our study, though we tried to capture some of this dimension in our own measure of implementation quality. As described in the CBAM research, the LoU addresses *"what a teacher is doing or not doing in relation to the innovation"* (Hall & Hord, 1987, p. 14). Three levels of nonuse and five different use levels have been identified in the CBAM research: nonuse, orientation, preparation, mechanical use, routine use, refinement, integration, and renewal. The third dimension, Innovation Configurations, *"focuses on describing the operational forms an innovation can take"* (Hall & Hord, 1987, p. 14). Defining this dimension for any particular innovation requires specifying its operational components (such as materials used, grouping procedures, etc.) and then identifying the variations that might be found within each component as the program is made operational in classrooms.

7. We performed a principal components analysis of the seven SoC scales that yielded two factors accounting for 74 percent of the total variation on these scales in January and 71 percent of the total variation in May. The first factor appears to assess the overall intensity of concerns about the innovation, as all seven stages of concern are positively correlated with this factor. However, the second factor is more useful as a measure of progress, since it detects contrasts in earlier vs. later stage concerns. Persons who score high on this factor have stronger later stage concerns, and those who score low have stronger earlier stage concerns. Those who score near the middle have concerns that are more or less equally intense across the seven stages. The second factor is positively correlated with our measure of implementation quality as well as teachers' feelings of expertise. The correlations with felt expertise are strongest in January when the survey questions on expertise were administered, and the correlation with implementation quality is strongest in May, which is when implementation quality was assessed. As a result of these findings, we are confident that our classification of teachers according to level of implementation is valid and can be used as the basis for further analyses.

8. The CBAM approach generally assumes the existence of an "archetype" in the minds of those who developed the innovation; alternative ways of implementing the innovation are thus always compared to the developer's implementation requirements, philosophy, and behavioral or functional model. ALS-EL, however, has been promoted as a flexible tool for language arts instruction, which can be adapted to fit differing teaching approaches and language arts curricula. ALS-EL has many components, i.e., a recommended hardware configuration, peripheral devices, an assortment of software programs, and an implementation manual suggesting classroom management and

curriculum strategies; within each component, many acceptable variations in use are possible.

9. The ALS-EL Teacher's Manual identifies three stations: (1) skills (Muppets on Stage with keyboard -- Muppet Learning Keys, Muppetville, Muppet Word Book, ColorMe, and Explore-a-Story: Where Did My Toothbrush Go?); (2) Sound (Sound Ideas, which includes a speech-synthesis card, Echo Speech Synthesizer); and (3) writing (Touch 'N Write, Talking Text Writer, Touch Window, Echo IIb). The manual recommends one Apple IIGS for the Skills Station, two Apple IIe Color Classroom Systems (for the Sound and Writing Stations), and one Apple Imagewriter II printer.

10. For each of the study sites, a building- or district-based "project leader" (normally a principal, assistant principal, or district personnel) was designated to coordinate with Lab staff on the study.

11. With a few key exceptions, we did not find strong correlations between our implementation measures and several teacher background variables that we thought might be of interest. The correlations were relatively low between all our measures and the teacher's age, years of teaching experience, and grade level taught. (There were no male teachers in our sample; hence, sex was omitted from the analysis.) However, these correlations are consistently negative, and the consistent pattern may be a trend worth noting. There are strong correlations between a number of implementation measures and the highest degree earned by the teacher; however, as we can think of no explanation for this phenomenon, we think these correlations must be spurious (i.e., due to an intervening variable). Not surprisingly, the number of years since the teacher first used microcomputers for classroom instruction correlates positively with the teacher's felt expertise in the general use of computers and in managing computers. However, prior experience appears to have been of little assistance in gaining familiarity with the ALS-EL program and learning to use its software effectively.

12. There is a richly-woven complex of factors that make up a classroom environment into which ALS-EL is assimilated most readily. While a large, open classroom with many kinds of ongoing teaching-learning situations may describe both a physical setting and a teacher's overall approach to the teaching-learning process conducive to ALS-EL implementation, a complex overlay of additional forces, (e.g., teachers experiences with and attitudes toward the innovation, competing demands on teacher time, training, support, leadership, perceived value of ALS-EL) also exerts a strong influence; all factors together determine the success of the implementation effort.

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